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REVIEW ARTICLE

Groin Dissection

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This review provides a brief history of groin dissection, including studies on anatomical considerations and technique. A groin dissection for complete ablation of the node-bearing areolar tissue in the inguinal and iliac regions and with negligible morbidity requires careful attention to the pathophysiology of cancer in lymphatics, pre- and postoperative care, and surgical technique, including coordinated use and general, plastic, vascular, and orthopedic surgical principles.
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This review provides a brief history of groin dissection and reviews studies on anatomical considerations and technique. My interest in this operation grew during the course of my surgical residency at Barnes Hospital (1952–1959). The morbidity was significant, and there was considerable disagreement about when the operation should be done. In 1961, when I assumed the position of chief surgeon at the Ellis Fischel State Cancer Hospital (EFSCH), I was confronted with the need to answer questions about indications for the operation and how to improve the surgical technique and reduce the morbidity attending it. A series of studies [1–4; Dillard and Spratt, unpublished data] ensued, culminating in 1965 [5]. Subsequently, additional studies have led to further insight into indications and a slight modification in surgical technique for some situations [6–8]. As will be discussed, studies reported by others since 1965 have further defined the indications and led to modifications in technique.

Historically, Basset [9] first described the operation in 1912. Other early students of the operation were Taussig [10], Baronofsky [11], and Woodhall [12]. However, MacCormac [13] reported the operation for penile cancer in 1886. Anatomical insight essential to determine the extent of surgical dissection was provided by Rouviere [14], Daseler and co-workers [15], and Uhlenhuth and Hunter [16].

Important studies also appeared on the physiology and the healing of lymphatics [17–21]. Lymphangiography was emerging in 1965 as an instrument for demonstrating the dynamics of the lymphatic system [22–24; S. Wallace, personal communication]. Kinmouth [25] provided comprehensive expansion of the operation in 1982. Belisario [26] had documented the better prognosis of superficial melanomas and their lower probability to metastasize to lymph nodes of the groin.

The study material available for my 1965 text [5] included records at EFSCH dating from the opening of the hospital in 1940. Pathologic study slides, paraffin blocks of original cancers, and a unit record system with 100% follow-up on all cases to the date of each study were available. Obviously, all studies were to be a review of past experience because no controlled clinical trial had been done, and none remains really possible for less frequent neoplasms. The infrequency of many cancers that metastasize to the lymph nodes of the groin portends difficulty in obtaining needed statistical power with controlled clinical trials. Aside from technical improvements to minimize morbidity and mortality, the dominant question was "when is a prophylactic groin dissection indicated?" Whenever no palpably enlarged lymph nodes were present and a groin dissection was done, it was

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considered "prophylactic." When the indication for surgery was palpably enlarged lymph nodes believed to contain cancer, the dissection was considered "therapeutic" whether the conditions existed initially or developed later. A total of 148 patients were available for study, with cancers in various anatomical sites: penis, vulva, vagina, melanoma, anus, and the lower extremity (epidermoid carcinomas). Later studies reported additional patients with melanoma and cancer of the penis [6,7]. The working hypothesis was that the probability of metastasis to inguinal lymph nodes was a function of the surface area of the neoplasm that was in contact with the lymphatics. It was well known that melanomas could be either superficial or deep, and the lower probability of lymph node metastases associated with the more superficial melanomas seemed to have a better prognosis [26]. Superficial was defined as no penetration of cancer deep to the corium or sweat glands [27].

The increasing accessibility of high-frequency ultrasound units may lead to improved staging accuracy of lesions thought to be melanoma. Mansfield and associates [28] reported that ultrasound can be used to scan the entire lesion, permitting selective biopsy of the thickest part and confirming actual thickness. This approach would be applicable to any cutaneous neoplasm, to determine thickness.

Lubach et al. [29] concluded that the malignant aggressiveness of a melanoma depends on both the width and the depth of the primary tumor and is directly related to the arrangement of lymphatics in different layers of the skin. Sudden increases in the density of lymphatic vessels occur adjacent to melanomas and are associated with an incremental increase of the seeding of malignant cells via the lymphatics. Thus, some melanomas will have disseminated systemically at the time of diagnosis.

The survival data clearly established the benefit of therapeutic groin dissections for both long-term survivorship and the palliative local control of cancer in the groin. The justification for prophylactic dissections was addressed by comparing harm to benefit in the retrospective data. Confirmation of indications for prophylactic dissections was considered so marginal in some instances that a controlled clinical trial was obviously necessary. The small differences between survival end points necessitated the need for very large numbers of patients to attain necessary statistical power. Since these studies, some controlled clinical trials have been completed and the technique of sentinel node biopsy has been introduced. These will be reviewed below.

The most recently reported controlled clinical trial, on 552 patients, concluded that patients younger than age 60 years benefited from prophylactic lymph node dissection, whereas those over age 60 years had a worse outcome [30]. The under 60 age group had the most favorable outcome when the melanomas were between 1 and 2 mm thickness with no tumor ulceration. In this study, no melanoma had recurred after 9 years of follow- up. The fact that melanomas may still recur in this series is completely in keeping with estimates of survival based on growth rates. From the estimated doubling times of pulmonary metastases from melanomas, we theorized that survivorship would range from 280 to 5,640 days with 95% confidence and from 160 to 11,800 days with 99% confidence. The median survivorship from onset would be 1,720 days [6]. There exists a strong possibility that the major determinant of survivorship with melanoma is its rate of growth.

ANATOMY OF THE ILIOINGUINAL REGION

Any surgical operation requires a clear understanding of the regional anatomy. The object of an ilioinguinal (groin) lymph node dissection is to remove the lymph nodes and lymph channels of the ilioinguinal region en bloc. The anatomical features of this region not only determine the technique and the extent of the operative procedure but also influence the indications for it. The extent of the operation is often determined by the extent and nature of the cancer. That is, deep iliac or obturator lymph node dissection is not always necessary, and the indications for deep dissection might be further reduced by identification and biopsy of the sentinel lymph nodes in some instances or by frozen-section examination of Cloquet's node in the inguinopectineal triangle, constituting the high point of superficial groin dissection. If a cancer arises in an area drained by the superficial inguinal lymph nodes and Cloquet's node is free of metastases, the deep nodes will be involved infrequently.

Ilioinguinal lymph node dissection encompasses the removal of all lymph node–bearing tissues from the bifurcation of the common iliac artery (into internal and external iliac arteries) to the passage of the femoral artery beneath the sartorius muscle near the apex of the femoral triangle. The areolar adipose lymph node–bearing tissues from the retroperitoneal region along the external iliac artery and from the region of the femoral triangle are removed.

Anatomical landmarks are helpful in outlining the region involved in this operation. In the thigh, the femoral triangle (trigone of Scarpa) is an extremely significant anatomical unit (Fig. 1). The inguinal ligament runs from the readily palpable anterior superior iliac spine to the pubic tubercle and lies superior to the inguinal skin crease. The inguinal ligament (and not the lower skin crease of the groin) forms the upper border or base of the femoral triangle. The sartorius muscle passes obliquely downward and inward from the anterior superior iliac spine to the medial side of the knee and forms the lateral border of the femoral triangle. The medial border of the femoral triangle is formed by the medial edge of the adductor longus muscle. Its tendon, inserting on the pu-

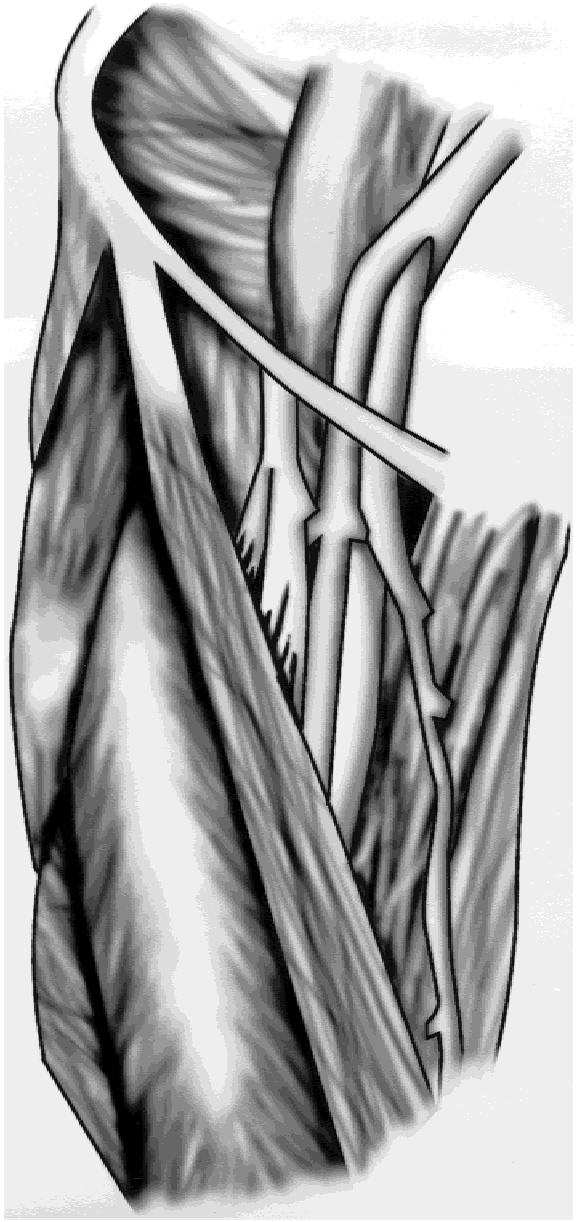

Fig. 1. Anatomical relations of the contents of the femoral triangle to the iliac blood vessels. Reproduced with permission from Spratt et al. [5].

bic tubercle, is easily palpated when the thigh is adducted against resistance. Significant lymph nodes seldom are found at the medial border of the adductor longus muscle, and dissection is usually not extended that far medially [15]. The floor of the femoral triangle is formed by the fascia overlying the iliopsoas muscle laterally and the adductor longus and pectineus muscles medially. The roof of the femoral triangle is formed by the fascia lata. The subcutaneous tissue overlying the femoral triangle superficial to the fascia lata is not within the femoral triangle. The greatest number of inguinal nodes are found in the subcutaneous tissue (the superficial inguinal

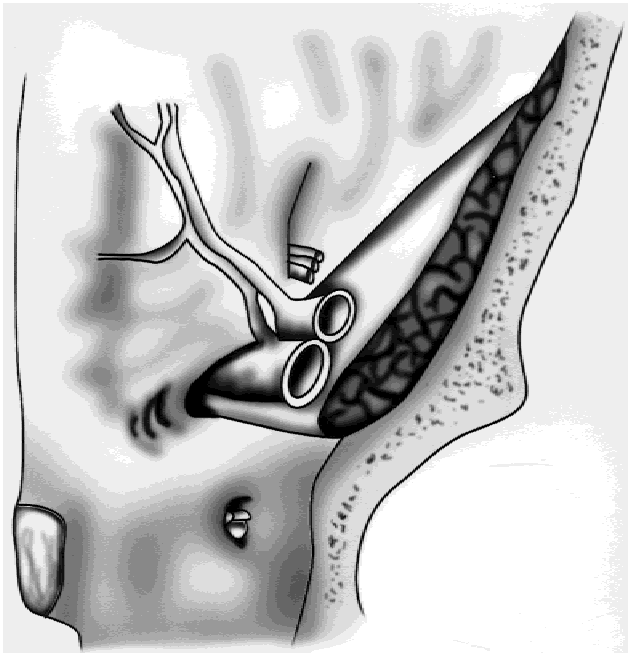

Fig. 2. Relation of the femoral artery, vein, and nerve as they pass beneath the femoral arch of the inguinal ligament and through the inguinopectineal triangle as viewed from above. Also shown is the obturator canal through which pass the obturator nerve, artery, and vein. The fatty areolar tissue in the femoral canal contains the major valvular lymphatics coming from the lower extremity with Cloquet's lymph node near its pedal entrance. Reproduced with permission from Spratt et al. [5].

nodes). They are frequently called femoral triangle nodes.

The inguinal ligament, in passing from the anterior superior iliac spine to the pubic tubercle, arches over the iliopectineal line and forms an important space, the femoral arch (Fig. 2). A band of iliac fascia runs from the inguinal ligament to the iliopectineal eminence and forms the iliopectineal ligament. It divides this femoral arch into 2 spaces. The lateral space (lacuna musculorum) is occupied by the iliopsoas muscle and the femoral nerve. The medial space (lacuna vasorum) contains the femoral vessels (the artery is lateral and the vein is medial) and the femoral canal medial to the vein. The femoral sheath is the continuation of the iliac fascia and the transversalis fascia into the thigh, surrounding the femoral artery, vein, and canal as they pass through the lacuna vasorum. The gap between the femoral vein and the lacunar (Gimbernat's) ligament is occupied by the femoral canal. The femoral canal is a narrow space lying most medial in the femoral arch and contained within the femoral sheath. It can be considered the lymphatic compartment of the femoral arch and usually contains 1 or 2 deep inguinal nodes in addition to several valvular lymphatic channels in its areolar-adipose contents. The abdominal (or superior) slit-like aperture of the femoral canal is the femoral ring. At this point lies Cloquet's node, the high point of superficial dissection.

The common iliac artery divides into the external iliac and the internal iliac (hypogastric) arteries approximately at the level of the sacroiliac joint. The ureter usually crosses the iliac vessels about the level of the bifurcation of the common iliac artery. Thus, the ureter must be considered and avoided at the "high point" of the node dissection located at the bifurcation of the common iliac artery. The hypogastric artery runs posteriorly and inferiorly into the pelvis. The external iliac artery runs laterally along the pelvic wall against the iliopsoas muscle, covered by the peritoneum and the endopelvic fascia, until it passes beneath the inguinal ligament at the lacuna vasorum of the femoral arch and becomes the common femoral artery. Just before it passes beneath the inguinal ligament, it gives off its only 2 branches: (1) the deep circumflex iliac artery that runs laterally from the external iliac artery and (2) the inferior epigastric artery that runs anteriorly and medially along the anterior abdominal wall posterior to the rectus abdominis muscle.

On occasion, the obturator artery arises from the inferior epigastric artery instead of from its usual origin, the hypogastric artery. When this occurs, it passes inferiorly from the inferior epigastric artery and may be identified during a groin dissection or during the repair of a femoral hernia.

The external iliac vein extends from the inguinal ligament (as a continuation of the common femoral vein) medial and posterior to the external iliac artery until it joins the internal iliac (hypogastric) vein to form the common iliac vein. It receives the deep circumflex iliac vein and the inferior epigastric vein, which accompany their arterial counterparts.

The common femoral artery enters the thigh beneath the inguinal ligament about halfway between the anterior superior iliac spine and the pubic tubercle, encased in the femoral sheath. Its pulsation is palpable, making its position easy to identify. It passes distally into the thigh, always lying beneath the fascia lata. The femoral artery gives off 3 superficial branches that pierce the fascia lata shortly after it emerges from beneath the inguinal ligament: (1) the superficial circumflex iliac artery (originating laterally), (2) the superficial epigastric artery (originating medially), and (3) the superficial external pudendal artery (originating medially). These branches are encountered and ligated in the course of an inguinal node dissection. The deep branches of the common femoral artery in the femoral triangle, the deep external pudendal artery, and the deep (profunda) femoral artery are not usually identified per se during a groin dissection. After giving off the deep (profunda) femoral artery about 4 cm below the inguinal ligament, the superficial femoral artery continues distally into the thigh, always lying deep to the fascia lata and encased by the femoral sheath as far as the apex of the femoral triangle. The femoral vein accompanies the femoral artery in the thigh, always being deep to the fascia lata and encased by the femoral sheath as far as the apex of the femoral triangle. The femoral vein lies medial to the artery at the level of the inguinal ligament but gradually becomes more posterior as it comes distally from the thigh. Corresponding with the arterial nomenclature, the common femoral vein in the upper thigh is formed by the junction of the femoral vein (a continuation of the popliteal vein) and the deep (profunda) femoral vein.

The greater saphenous vein runs in the anteromedial thigh in the subcutaneous tissue. It pierces the cribriform fascia (of the fascia lata) at the fossa ovalis and empties into the femoral vein. In the course of an inguinal node dissection, the saphenous vein must be ligated twice: (1) in the subcutaneous tissues as it enters the inferior margin of the operative field and (2) as it turns deep to join the femoral vein at the fossa ovalis. Because the channels carrying the major lymphatic drainage of the leg accompany the saphenous vein in the thigh, it is wise to ligate the areolar-adipose tissues surrounding the saphenous vein at the pedal border of the dissection. This assures blockage of the major source of lymph coming from the lower extremity. Thus, it cuts down on postoperative accumulation of fluid beneath the skin flap and decreases the possibility of postoperative lymph fistulas.

The other tributaries of the femoral vein lying superficially that are encountered in an ilioinguinal node dissection are the accompanying veins to the superficial branches of the femoral artery. They are (1) the superficial circumflex iliac vein, (2) the superficial epigastric vein, and (3) the superficial external pudendal vein. Their entrance into the femoral vein is extremely variable. Usually, they join the saphenous vein just before it enters the femoral vein, but frequently 1 or more may enter directly into the femoral vein by piercing the fascia lata independently. The superficial inguinal lymph nodes tend to parallel the superficial tributaries of the femoral vein.

NERVES

The femoral nerve is the most significant nerve to the surgeon in the performance of an ilioinguinal node dissection. Division of the femoral nerve creates considerable morbidity because it innervates the quadriceps, sartorius, and pectineus muscles and supplies sensation to a large part of the skin of the anterior and medial portions of the thigh.

In the pelvis, the femoral nerve runs deep to the iliac fascia in a groove between the iliacus and the psoas major muscles. It approaches the iliac artery, and as these structures pass beneath the inguinal ligament, the femoral nerve lies lateral to the femoral artery. A small portion of the psoas major muscle separates the artery and the nerve. Shortly after entering the thigh, the nerve divides

into its many branches and immediately passes beneath the sartorius muscle out of the field of the dissection (Fig. 1).

The genitofemoral nerve marks the lateral margin of the iliac portion of the node dissection. In the region of the external iliac artery, it lies on the surface of the psoas major muscle, covered by peritoneum. Occasionally, it divides into 2 terminal branches, the external spermatic nerve and the lumboinguinal nerve, as it parallels the external iliac artery. These 2 branches may then be identified instead of a single genitofemoral nerve. The external spermatic nerve lies lateral to the external iliac artery; the lumboinguinal nerve lies on the anterior surface of the external iliac artery and passes with it beneath the inguinal ligament. It then penetrates the fascia lata to innervate a portion of the skin of the groin.

The obturator nerve emerges from the medial border of the psoas major muscle at the brim of the pelvis. It passes behind the common iliac vessels and runs lateral to the hypogastric artery and vein, lying on the obturator internus muscle. It continues in the obturator canal (Fig. 2).

LYMPHATICS

The lymphatic system consists of 2 major portions: (1) a complex system of intercommunicating capillaries and vessels, which conducts lymph from the periphery and empties it centrally into the venous system, and (2) the lymph nodes or glands, which are interspersed along the lymphatic channels and serve various functions including filtration, lymphocyte production, and antibody production. A distinction is to be drawn between the tissue fluid circulating in the tissue spaces (between the cells) from the lymph and the fluid contained within the closed system of lymph vessels.

Lymph circulates through the skin via a system of closed vessels [18]. The cutaneous lymphatic circulation arises in the subepithelial region of the dermis (Fig. 3) as a superficial plexus of capillaries, with papillae extending up toward the epidermis. This valveless plexus is continuous over the entire surface of the body, although it normally drains only a small area. There are no lymphatic vessels in the epidermis. The subepithelial plexus is connected by oblique and vertical trunks to a system of larger lymphatic vessels in the subdermal region. The walls of the vessels of the superficial or subepithelial capillary plexus are composed of endothelium alone. There is no differentiation of adventitia or formation of muscular coats around these vessels.

The subdermal plexus of lymphatics is a system of collecting radicals containing valves to ensure a unidirectional flow of the lymph. Lymph flows from the subdermal plexus into a subcutaneous plexus, the major lymph trunks conducting fluid from the periphery. In addition to valves, the vessels of the subcutaneous plexus contain a muscular layer that converts the lymph drainage at this level from a completely passive to a partially active process. This system of lymph vessels in the subcutaneous tissue carries the lymph to the regional nodes. There is a system of deep lymphatics (i.e., deep to the muscular fascia) that is much less extensive than the superficial system. This deep system drains the large muscular compartments, but the largest portion of the deep drainage, by volume, comes from the joints and the synovial tissues. Lymphatics are sparse within the muscles themselves because there are relatively few channels passing through the deep fascia connecting the superficial system and the deep system. Flow through the channels connecting the superficial system and the deep system normally is from the deep system to the superficial system (the opposite of normal venous drainage).

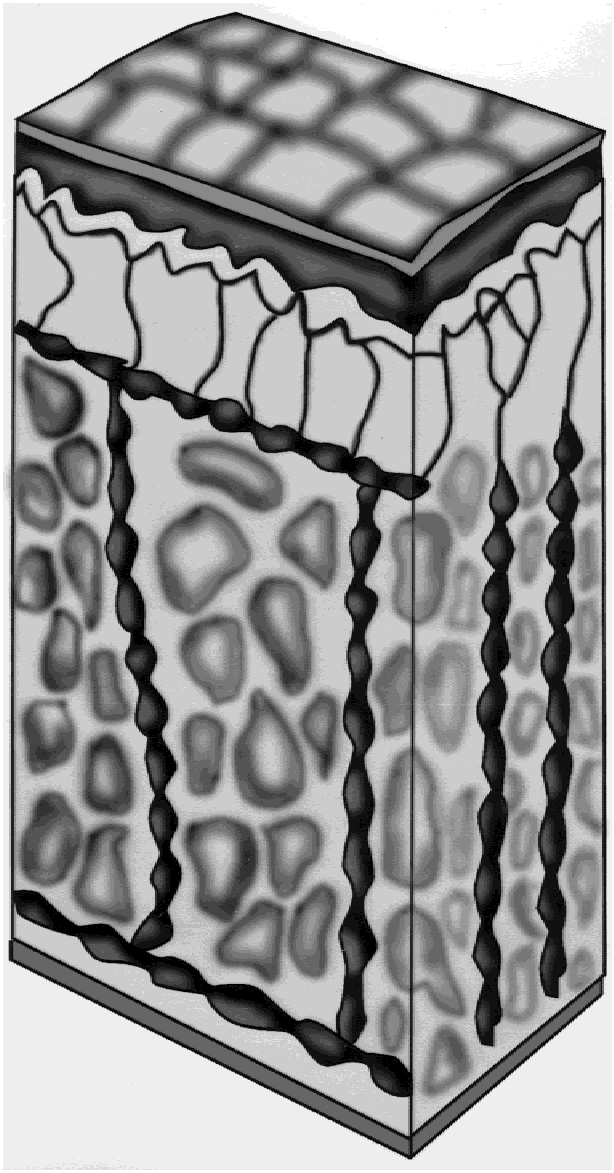

Fig. 3. Schematic representation of lymphatic anatomy of the skin. Reproduced with permission from Spratt et al. [5].

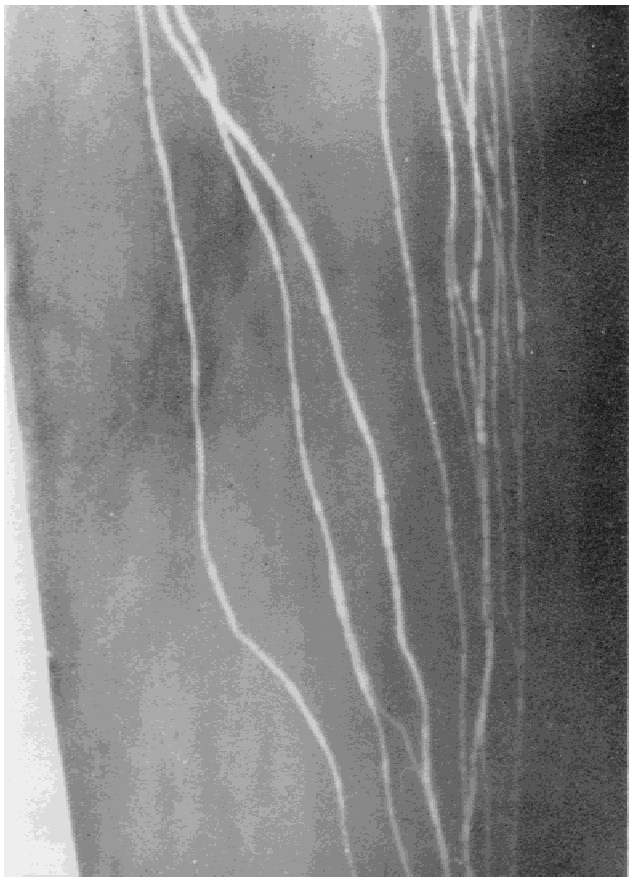

Fig. 4. Magnified view of normal lymph channels of the thigh. Regularly spaced valves are apparent with no change in lymphatic diameter. Reproduced with permission from Spratt et al. [5].

The most significant connection between the 2 systems is at the level of the inguinal lymph nodes, where both superficial and deep systems join to form a common trunk. Thus, each system (superficial and deep) functions independently of the other under usual circumstances.

Even though the vessels in the subcutaneous system divide and reanastomose with each other, their caliber remains approximately the size of a 27-gauge needle, seldom increasing as they proceed toward the regional lymph nodes. There are valves with paired cusps placed throughout this system (Fig. 4). Distal to each valve, a small constriction is present, and, proximal to each valve, a small dilatation of the lumen is present.

Because the lymph channels of the subcutaneous system form a network by their method of anastomosing and branching, bypass channels for any particular lymph node or group of lymph nodes are present (Fig. 5). Thus, lymph may bypass nodes and continue to the next higher node or group of lymph nodes. Therefore, although lymphatic metastases usually follow a regular and specific stepwise pattern, any particular node or lymph node group can be missed by tumor cells within the lymphatics

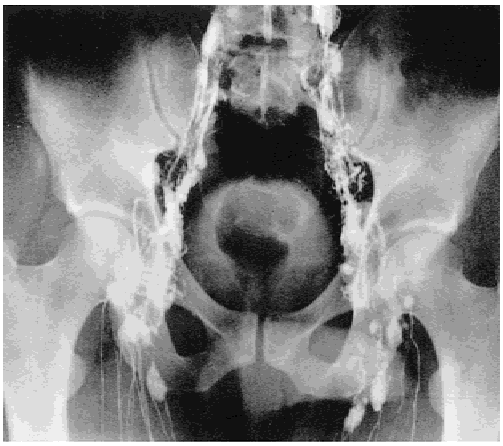

Fig. 5. Lymphogram of the upper thigh and pelvis showing subinguinal group of nodes with continuation of the lymphatics through the femoral space into the external iliac lymph nodes. Reproduced with permission from Spratt et al. [5].

and metastasis may appear at a higher level. How often this bypass would affect the accuracy of sentinel node identification is not known. Theoretically, the lymph nodes may be deprived of the opportunity to function as filters for endolymphatic cancer cells in 2 other anatomical situations: lymphatics have been observed rarely to empty directly into veins without passing through lymph nodes [30,31] and cancer cells may pass directly from a lymph node containing metastatic cancer into the efferent veins, as well as into the efferent lymphatics of the node [31].

Because of the valvular structure of the main lymph channels (Fig. 4), flow of lymph in a unidirectional fashion is maintained. Therefore, retrograde lymphatic metastases occur only when proximal lymphatics are blocked, the lymphatic channels dilate, and the valves in the deep lymphatics become incompetent.

The lymphatic system (nodes and channels) is a continuum of channels without specific anatomical demarcation (Fig. 5). For convenience of description, lymph nodes have been artificially and arbitrarily divided into groups that are named by their anatomical surroundings. This grouping gives the impression of specific and discontinuous lymph node groups, each draining certain anatomical regions and structures. However, the lymphatic system is composed of a network of interconnecting vessels that form a continuous chain of channels with interspersed nodes. Certain organs and anatomical regions are drained by lymphatics that usually end in certain specific nodes. However, the continuum of the lymphatic system makes the division of lymph nodes into groups an artificial one imposed by the anatomist. Small cancers with limited lymphatic dissemination might favor limited involvement of a sentinel node.

Lymph nodes encountered in an inguinal node dissec-

tion lie in 2 major anatomical regions: (1) the femoral or subinguinal region and (2) the retroperitoneal or parailiac region. A detailed description of the surgical anatomy of the lymph nodes of these regions is given by Daseler et al. [15]. The anatomical surroundings of the nodes in these 2 areas make dissection somewhat different in character. In the retroperitoneal area, the nodes are held together by thin, filmy areolar tissue, except in obese patients with encasing fat that may be extensive. The fragile nature of this tissue and the proximity of large valveless pelvic veins dictate that dissection in this region be exact. Care must be maintained to keep the specimen in 1 block. The tissues below the inguinal ligament in the femoral region contain more fat and more supportive fascia, and dissection in this region is maintained more easily en bloc. Because of the differences in the type of dissection and because of the fact that inguinal node dissections must of necessity be done in 2 phases (that above the inguinal ligament and that below it), the nodes in these regions will be considered separately. The nodes above the inguinal ligament and in the retroperitoneal space are the external iliac nodes; those below the inguinal ligament in the thigh are the inguinal or femoral nodes.

The major number of, and the most and important lymph nodes in, the inguinal region lie superficial to the fascia lata and are called the superficial inguinal nodes. Arbitrarily, inguinal nodes are frequently divided by a line drawn horizontally through the junction of the greater saphenous vein and the femoral veins into superior (or high or inguinal) superficial nodes and inferior (or low or femoral or subinguinal) superficial nodes.

The superficial inguinal nodes receive afferent lymphatics from the superficial lymphatics of the lower extremity (the leg and medial thigh enter the lowest group of nodes). The lateral thigh tends to drain into higher lymph nodes. Lymphatics from the scrotum (but not the testicle or the spermatic cord), the vulva (i.e., labia majora and labia minora), the penis or clitoris, the anus and perianal skin, the skin of the buttocks and perineum, and the skin of the anterior abdominal wall below the umbilicus also tend to drain into the higher lymph nodes. The superficial inguinal nodes then drain via efferent lymphatics into the deep inguinal nodes and thence into the iliac nodes. Some lymphatics pass directly into the external iliac nodes.

The deep inguinal nodes are those in the thigh that lie beneath or deep to the fascia lata. They are usually few in number, and occasionally only 1 exists. The deep inguinal nodes almost always lie medial to the femoral vein. The most consistent of the deep inguinal nodes and frequently the only node present is the lymph node of Cloquet. This node lies in the femoral canal between the femoral vein and the lacunar ligament. The deep inguinal nodes drain the deep lymphatic trunks that accompany the femoral vessels (including channels from the popliteal nodes) and the superficial inguinal lymph nodes. The deep inguinal nodes drain directly into the external iliac nodes and form a continuous lymph cord with them. Cloquet's node has surgical importance since it marks the high point of the inguinal lymphatic complex and may be submitted for frozen-section examination. If the groin dissection is being done for cancers of the lower extremity and Cloquet's node contains no metastases, dissection of the iliac nodes may not be indicated.

A lymph node that must be considered with the superficial inguinal group of nodes is one that is occasionally found in the subcutaneous tissue anterior to the pubic symphysis. This is called the prepubic node. This node, when present, receives channels from the penis (or clitoris) and drains into the superficial inguinal lymph nodes. On occasion, metastatic carcinoma arising in the penis, clitoris, or vulva may be found in this node and may recur in the presymphyseal region if this node is left behind at the time of groin dissection.

The external iliac lymph nodes surround the external iliac vessels. They are classically divided into 3 groups: lateral, medial, and anterior (or middle) lymph nodes. However, this division is arbitrary and has no true functional significance because nodes in all locations send afferent channels and receive efferent channels from the others. One external iliac node is occasionally placed adjacent to the pelvic aspect of the obturator foramen in proximity to the obturator artery and nerve. This is called the node of the obturator foramen (or obturator node). It is a true member of the external iliac group [14,15], not of the hypogastric chain, and should be removed in ilioinguinal node dissections. The external iliac nodes receive efferent channels from the inguinal nodes, both superficial and deep; from the deep lymphatics of the abdominal wall; from the lymphatics of the medial thigh accompanying the obturator vessels; and occasionally from part of the lymphatic drainage from the dome of the bladder, the prostate, the ductus deferens, the seminal vesicles, the membranous and prostatic urethra, the cervix and uterus, the vagina, the clitoris, the glans penis, and the hypogastric nodes. The external iliac nodes then drain into the common iliac nodes, where they are joined by the hypogastric channels.

The afferent and efferent channels of the various lymph node groups are summarized in Table I. The diffuseness of the drainage pattern, as emphasized by lymphography and by the summary in Table I, supports the argument that the only effective surgical treatment for most cancers draining to these lymph nodes is a complete en bloc removal of the superficial and deep inguinal lymph nodes and the iliac lymph nodes. The exceptions to this generalization will be discussed.

TABLE I. Source of Afferent Lymphatics and Destination of Interconnecting Efferent Lymphatics of the Ilioinguinal Region

Lymph node group	Afferent channels from	Efferent channels to
Superficial inguinal	Superficial lymphatics of lower extremity	External iliac nodes
	Scrotum	Deep inguinal nodes
	Vulva	
	Penis (or clitoris)	
	Anus and perianal skin	
	Skin of perineum and buttocks	
	Skin of anterior abdominal wall velow umbilicus	
Prepubic	Penis (or clitoris)	Superficial inguinal nodes
Deep inguinal	Deep lymphatics of lower extremity	External iliac nodes
External iliac	Superficial inguinal nodes	Common iliac nodes
	Deep inguinal nodes	
	Deep lymphatics of abdominal wall	
	Lymphatics of medial thigh accompanying obturator artery	
	Part of drainage from	
	Dome of bladder	
	Prostate	
	Ductus deferens	
	Seminal vesicles	
	Membranous and prostatic urethra	
	Cervix and uterus	
	Vagina	
	Glans penis	
	Hypogastric (internal iliac) nodes	

Reproduced with permission from Spratt et al. [5].

SURGICAL TECHNIQUE OF GROIN DISSECTION

The purpose of an ilioinguinal lymph node dissection (referred to subsequently as a groin dissection) is to remove all of the fatty areolar tissue containing the superficial and deep inguinal, iliac, and obturator lymph nodes by an en bloc fascial plain dissection. The operation is performed presuming (1) that these lymph nodes have acted as filters for the arrest of cancer cells arriving at the nodes via afferent lymphatics and (2) that these cancer cells entrapped in the lymph sinuses and in the juxtanodal lymphatics are viable and replicating. When the tumor mass in the lymph node resulting from multiplication and growth of the entrapped cells is sufficiently enlarged, the cancer may be expected to enter the efferent lymphatics to spread to the next group of nodes, to enter the bloodstream directly, or to invade the surrounding structures through the capsule of the nodes or via the juxtacapsular lymphatics. The cancer cells contained in these lymph nodes and in their lymphatics are further presumed to be implantable in an open wound, and careless surgical manipulation may be expected to increase the likelihood of wound seeding and local recurrence.

Delay in ascertaining the indications for a groin dissection favors the involvement of additional nodes by metastatic cancer. The number of nodes involved seems also to be determined by the biological aggressiveness of specific cancers. Delay also favors the development of cancerous nodes large enough to permit extracapsular cancer growth with the cancerous transgression of fascial plains.

Failure to extirpate these cancerous nodes may be expected to result in the death of the host either by generalized dissemination from the involved nodes or by complications related to sustained local growth. There is no indication for removal of these lymph nodes when they contain no cancer, and unnecessary removal can affect the host adversely, primarily because of the morbidity of the operation. Thus, the identification of cancers prone to metastasize to lymph nodes and their pattern of metastasis is an ongoing area of clinical research. Some cancers, unfortunately, bypass the entire lymphatic complex with early transvasal dissemination.

PREPARATION OF THE PATIENT

The general principles of preoperative evaluation of patients apply equally to patients who undergo groin dissections. Only those principles peculiar to groin dissection will be discussed.

The primary cancer should be controlled or controllable by the operation planned. In the preoperative evaluation, the presence of metastases beyond the ilioinguinal region should be excluded as far as possible. In general, palpatory examination of the abdomen and the supraclavicular region, a thoracic roentgenogram, and evaluation of any localized skeletal pain should be within normal

limits. If cancerous nodes are palpable in the groin and the diagnosis of distant metastases is uncertain, then it is better to proceed with the groin dissection to ensure control of cancer locally in the groin, which will be justified later. Computed tomographic (CT) scans and magnetic resonance imaging (MRI) now assist in the identification of asymmetrically enlarged internal iliac, obturator fossa, and aortic lymph nodes and are useful for the identification of hepatic, pulmonary, and brain metastases. Cancers metastasizing to the lymph nodes of the groin give rise to late or infrequent distant metastases, and we defer bone scans for only the occasional patient presenting with skeletal pain. In the presence of skeletal pain, a roentgenogram of the painful bone may demonstrate lytic changes in the bone, often making a bone scan unnecessary.

PREOPERATIVE LYMPHATIC STUDIES

Lymphography (lymphangioadenography) has been utilized in the preoperative evaluation and preparation of patients about to undergo groin dissection. The test is simple to perform and, when carried out properly, associated with minimal morbidity [22]. Lymphography performed in the preoperative period proved valuable in the past but has been replaced by newer techniques.

Lymphangiography allows visualization of the lymph channels and nodes not only in the area included in the operative field of groin dissection but also in the lymph drainage along the aorta proximally. When an oily dye is used for lymphangiography, it remains in the lymph nodes for months following a single intralymphatic injection and comparison films over this period can be readily obtained [5,22]. The use of lymphography in the search for occult metastatic deposits in individual nodes, to determine indications and/or candidates for node dissections, has not been worthwhile. Both false-positive and false-negative results occur much too frequently to ensure accurate identification of individual nodes containing a metastatic deposit.

The greatest value of lymphography in groin dissection in our earlier studies [5] was to ensure the completeness of lymph node removal at operation. When the patient had had lymphograms performed in the preoperative period with an oily dye, a roentgenogram of the operative field, taken at the conclusion of the node dissection and before wound closure, identified unresected lymph nodes. These postdissection studies provided excellent quality control for node dissections by various surgeons or by various operative techniques. The knowledge gained was helpful in designing surgical techniques to ensure a high probability of the en bloc removal of all lymph nodes.

Cancers giving rise to the need for groin dissection occur most frequently in elderly people. The aged tolerate major surgery quite well if they do not have to endure the added stress of major complications. The best way to ensure that elderly people will tolerate major surgery is to perform the indicated procedure in a technically correct manner with minimal trauma to the patient and minimal postoperative morbidity.

MECHANICAL CLEANSING OF THE LARGE INTESTINE

The postoperative management of the bowels is always a problem and can be simplified greatly by preoperative preparation. All patients should be given a low-residue diet before and during the hospital stay. The day before operation, a 24 hr preparation with Golytely (Braintree Laboratories, Braintree, MA) is initiated. On the evening preceding surgery, cleansing saline enemas may be required in some patients. If the bowel preparation depletes the extracellular fluid, preoperative replacement with electrolyte solution is indicated. Antimicrobial drugs are not employed for intestinal antisepsis because the preparation is strictly mechanical, reducing the likelihood of gross fecal soilage during the operative procedure and the first several postoperative days.

When the planned operation includes a vulvectomy or a dissection close to the anus, an additional procedure should be carried out. Early on the morning of surgery, an additional cleansing enema is administered. When the patient is positioned on the table, a large de Pezzer catheter should be inserted through the anus, sutured to the perineal skin, and attached to a drainage tube and bottle. This provides assurance of last-minute mechanical cleansing, decompression of the rectal ampulla during the ensuing operation, and reduction of the chance of surgical field soilage. Postoperative nursing care is simplified by the delayed onset of fecal evacuation.

PREVENTION OF LYMPHEDEMA

The prevention of edema in the lower extremities begins preoperatively. Infection is treated actively by specific antibiotic therapy, topical cleansing, and elevation and rest of the involved extremity. All patients are measured preoperatively for graded elastic stockings, which should be available at the time of operation and worn in the immediate postoperative period or preoperatively. The fitted elastic stockings begin at the metatarsophalangeal joints, cover the heels, and extend to the knees or the mid-thighs. They remain in place to prevent edema until the patient's wounds are completely healed and until he or she is ambulating well. They are worn during the first 6 postoperative weeks, during the period of lymphatic regeneration. If there is any delay in wound healing, the 6-week period begins when the wound has healed. Wearing the stockings may then be discontinued, but they should be put on promptly when the least trace of edema appears. Lymphatics regenerate but never completely restore preoperative lymph flow. Treves [32] has shown

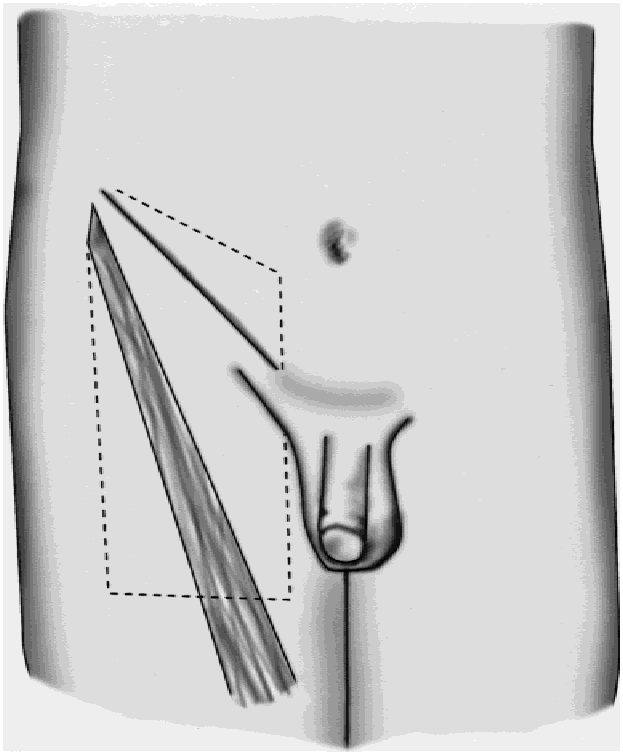

Fig. 6. The dashed line delineates the quadrilateral block of superficial fascia and fatty areolar tissue containing the superficial inguinal lymph nodes. The 4 corners of the block are situated at the anterior superior iliac spine, a point 20 cm distally on the thigh measured from the anterior superior iliac spine, a point 2 cm cephalad from the pubic tubercle at the level of the upper margin of the external inguinal ring, and a point distal from the pubic tubercle on the inner thigh at the same level as the point on the outer thigh. The line joining the 2 points on the thigh crosses the apex of the femoral triangle where the sartorius muscle overlaps the adductor muscles. The skin flaps have to be elevated to the margins of this block, but care should be taken to ensure that subcutaneous dissection does not extend beyond the margins of the block, unnecessarily interrupting blood supply within the flaps. An indelible mark on the skin outlining the block before dissection starts will simultaneously ensure completeness of the resection and prevent unnecessary extension of the subcutaneous dissection when dissection stops at the line. Reproduced with permission from Spratt et al. [5].

equal reduction in lymph flow from an extremity with either resection or radiation of the regional lymph nodes.

THE OPERATING TABLE

The positioning of the patient on the operating table deserves careful consideration and planning. I have used most of the standard positions, and one has emerged as the most adaptable to the performance of groin dissections and the en bloc perineal organ resections sometimes performed simultaneously. The patient is positioned on an operating table with orthopedic attachments for abduction of the lower extremities (Fig. 6). When the need for a skin graft is anticipated, 1 thigh is prepared circumferentially, and a separate sterile setup is used for draping. The graft is taken from the skin below the groin dissection site, and the donor site is dressed with a pressure dressing or simply with Adaptic. Then, the well-padded heels and feet can be bound into the orthopedic attachments and the legs wrapped to the extensions, to prevent slippage.

PREPARATION OF THE SKIN

The skin of the abdomen, thighs, perineum, genitalia, and perianal region can then be prepared. Hair-bearing areas are shaved. The skin and vagina are cleansed with povidone-iodine. Even when the surgery will be limited to a single groin dissection and no perineal or genital surgery is contemplated, mechanical cleansing and antiseptic preparation of these areas are still necessary because they are a major source of bacterial contamination in proximity to the surgical field.

The presence of an exposed or open cancer that must be removed en bloc with the nodal dissection merits a further preoperative precaution. The open cancer is a potential source of wound seeding and is always infected. These open cancers, when possible, may be cleansed by applying povidone-iodine soaks preoperatively. Surface microbial cultures should be taken of open cancers to determine antimicrobial sensitivities. Knowing the antimicrobial sensitivities is useful in the selection of antibiotics. The exposed cancer should be covered with povidone-iodine packs sutured into place before any skin incision is made.

SKIN INCISION

The vascular supply to the skin flaps that must be elevated to obtain access to the lymph node–bearing areas of the groin is peculiarly critical. Much of the bad reputation of groin dissections is related directly to the former frequency of ischemic necrosis of skin flaps. In the moist, glabrous folds of the groin and the perineum, such necrosis can be complicated by secondary infection, a long delay in wound healing, and probably an increased risk of lymphedema secondary to delayed lymphatic regeneration. The blood supply of the flaps is derived primarily from superficial external pudendal, superficial circumflex iliac, and inferior (superficial) epigastric arteries. All 3 of these vessels are transected and ligated during the course of the dissection, and the flaps must rely on anastomotic branches and the microcirculation in the flaps. These branches lie in Camper's fascia and tend to parallel the natural skin creases. In the inguinal region, the skin creases and subcutaneous anastomotic plexus tend to parallel the inguinal ligament. Consequently, the most physiological skin incision would be one paralleling the natural skin folds, transecting as few anastomotic vessels in Camper's fascia as possible. Both Baronofsky [11] and Woodhall [12] emphasized the importance of making the skin incision parallel to the inguinal ligament, to ensure the maximal likelihood of primary wound healing without flap necrosis.

Delayed wound healing or flap necrosis invariably results in prolonging the hospital stay. The length of the hospital stay has been correlated with the types of incision employed [5]. The oblique incision associated with the least risk of flap necrosis is a straight-line cut made parallel to the inguinal ligament, extending from the anterior superior iliac spine to the pubic tubercle. The straight vertical and S-shaped incisions cut across the anastomotic vessels in Camper's fascia and are associated with a high incidence of medial flap slough and wound separation. Any postoperative swelling of the thigh puts traction on these latter incisions. The length of the hospital stay after groin dissection as a function of wound morbidity was dramatically correlated with the type of incision over a period of 24 years. The highest likelihood of primary wound healing occurred with the oblique incision regardless of the surgeon or the year. Consequently, only the straight oblique incision parallel to the inguinal ligament was recommended [5], with some modifications to be discussed later.

The incision has the added advantage of permitting ready access with good exposure for the iliac dissection and the obturator dissection. Also, medial extensions of the oblique incision blend into the incisions necessary for radical vulvectomy or penectomy when en bloc resections of nodes and organs are required. A segment of undivided skin should be preserved, if the cancer and enlarged lymph nodes permit, when the inguinal incision is used in combination with a perineal incision. The peritoneal cavity can be entered readily through this incision for the purpose of exploration, should this be indicated. Bilateral oblique inguinal incisions can be joined across the midline; and by transection of the recti suprapubically, an incision is provided that gives superb exposure to the pelvic cavity. This procedure is mentioned because a pelvic surgical procedure in conjunction with a groin dissection is indicated occasionally. A midline incision separated from the groin incisions is generally preferable.

The sacrifice of skin and the need for skin grafts must be anticipated in the preoperative planning. Skin must be sacrificed if it is overlying enlarged lymph nodes and elevation of overlying skin would risk exposure of the nodes. The oblique incision is modified simply to circumscribe this skin, and the sacrificed skin is removed en bloc with the node-bearing tissue. Similarly, large areas of perineal skin may be sacrificed with en bloc resections of the vulvar, penile, or scrotal cancers. When skin is resected, the skin edges must not be approximated under tension for primary closure, a procedure that is certain to tent skin over irregular surfaces, form a dead space, and predispose to wound separation and fluid collection secondary to the tension of closure. A better course is to suture the margins of the flaps to the deep tissues without tension and to apply split-thickness skin grafts to the defects. Consequently, when the need for skin graft is recognized preoperatively, the procedure should begin with the preparation of a donor site and the taking of a split-thickness skin graft of adequate size. The graft is then stored in saline containing aqueous penicillin on the nurse's sterile table while the rest of the operative procedure is in progress, waiting to be used at the time of closure.

Preliminary delineation of the extent of the superficial portion of the groin dissection will help prevent the unnecessary elevation of skin flaps beyond the extent of the node-bearing fat. The extent to which flaps need to be elevated is determined by the limits of the quadrilateral block described by Daseler et al. [15]. These authors, on the basis of 450 anatomical dissections, concluded that superficial inguinal and subinguinal lymph nodes are rarely present outside of an imaginary line drawn from the level of the pubic tubercle to the anterior superior iliac spine along the upper margin of the external inguinal ring, straight distally from the anterior superior iliac spine for 20 cm, circumferentially across the anterior thigh to encounter a line passing vertically down the inner thigh from the pubic tubercle. The lower margin of the block crosses the lower extent of the femoral triangle, where the sartorius muscle passes over the adductor muscles. Daseler and co-workers [15] named this the quadrilateral block, which is outlined with respect to the external landmarks in Figure 6. Light identifying marks on the skin made before the dissection begins can be referred to as the flaps are elevated, and the subcutaneous dissection is discontinued when these marks are reached. Extensive elevation of flaps beyond the field of indicated dissection adds an unnecessary interruption to the critical microvascular blood supply of the skin flaps, increasing the chance for flap necrosis.

The flaps are elevated by sharp or cautery dissection to the prescribed limits. The margins of the flaps are retracted gently with skin hooks or racks. A 2 mm thickness of fat is left on the undersurface of the skin to accommodate the microcirculation of the flaps. If the skin close to enlarged nodes precludes leaving of this margin of fat safely, the skin overlying the nodes must be circumscribed by the incision and removed with the nodes. Exposure under the inferior extent of the lower flap can be secured with a large, blunt-forked rack retractor or a Deaver retractor. However, this retraction, if prolonged and vigorous, may damage the microcirculation of the lower flap, increasing the risk of flap necrosis. To reduce this risk, we have made a technical modification in the incisions by making a separate incision across the distal end of the quadrilateral bloc. This modification is probably more useful for cancers of the lower extremity distal to the lower end of the femoral triangle than it is for most pelvic cancers, and its use is restricted. Often, in overweight people, exposure of the pedal end of the dissection is difficult and a distal incision is helpful [8].

SUPERFICIAL AND DEEP INGUINAL DISSECTION

The superficial inguinal nodes accompany the divisions of the saphenous vein and are situated in the fatty areolar tissue between the superficial fascia and the fascia lata. The deep inguinal nodes lie in the fibrofatty layer within the femoral sheath adjacent to the femoral vessels and in a plane continuous with the node-bearing areolar tissue about the iliac vessels. These deep inguinal nodes lie between the fascia lata (superficial to the femoral vessels) and the muscular fascia. Although this dissection can be done without sacrificing the deep fascia, I am reluctant to do this when the operation is being done for cancer arising in the lower extremity since the valvular lymphatics lie on the deep fascia. The objective is to perform a clean dissection in the avascular plain outside of the encompassing fascial layers. If occult extranodal extension of cancer exists, this technique avoids exposure of the nodes. After the skin flaps have been elevated, the fatty areolar tissue is incised straight through and around the entire circumference of the quadrilateral block.

On the lower abdomen, the incision is carried down to the external oblique aponeurosis at the upper margin of the external inguinal ring (Fig. 7). The incision through the fat at this level parallels the inguinal ligament throughout its length. The fat is cleanly reflected from the aponeurosis interiorly to the inguinal ligament. When operating for cancers arising in the genitalia, the presymphyseal lymphatic plexus containing the prepubic nodes and the areolar tissue of the spermatic cord must be included in the dissection. In female patients, the spermatic cord analogue does not have to be preserved. The external ring can be opened laterally and the round ligament transected and ligated flush with the internal inguinal ring. The cord is then reflected toward the genitalia for en bloc resection. Similarly, situations arise where it might be necessary to divide the spermatic cord.

The fat is similarly incised at the lateral, medial, and inferior extents of the quadrilateral block. At the deep point of the incision, the fascia lata will be encountered. This is also incised around the periphery of the block down to bare muscle. In dividing the fat of the superficial fascia and the fascia lata, large afferent lymphatics, though not visible, are also transected. The large valvular lymphatics lie on the superficial surface of the deep fascia. If these are left open, they will weep lymph into the wound for several days and sometimes become the source of troublesome lymphatic fistulas. As a precaution, this tissue at the margins of the quadrilateral block can be transected between clamps and ligated. The greater saphenous vein is found at the medial inferior extent of the block, and it must be transected and doubly ligated.

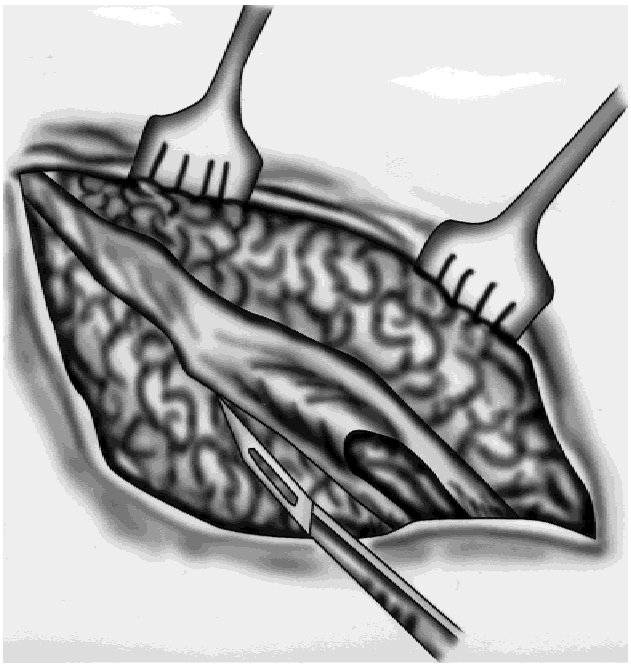

Fig. 7. After the superior flap has been elevated to the upper margin of the quadrilateral block, the incision is extended vertically through the fatty areolar tissue and superficial fascia down to the external oblique aponeurosis. The incised tissue is then dissected cleanly from the aponeurosis down to the inguinal ligament. In male patients, the spermatic cord is cleaned of fatty areolar tissue during this dissection. In female patients, when operating for vulvar or perineal cancer, the round ligament may be taken at this point by dividing the inguinal ring laterally, transecting and ligating the round ligament at the internal inguinal ring. Also, when operating for penile or female genital cancer, the areolar tissue overlying the pubis must be removed cleanly to ensure resection of the presymphyseal lymphatics and nodes. Reproduced with permission from Spratt et al. [5].

After the fatty areolar tissue has been completely transected, the fascia over the muscles is lifted up laterally over the sartorius muscle and dissected off of the underlying muscle. As reflection of the fascia progresses medially, muscular divisions of the femoral nerve will be encountered and can be followed upward for a clean dissection of the anterior surface of the main trunk of the nerve. Cutaneous branches passing through the quadrilateral block must be transected. The block of areolar tissue is detached laterally from the inferior edge of the inguinal ligament to the margin of the femoral sheath, exposing completely the main trunk of the femoral nerve as it appears beneath the ligament. Medially, the deep fascia is reflected up from the adductor muscles to the medial margin of the femoral sheath. During the course of this dissection, muscular divisions of the femoral artery and vein will be encountered and must be transected and ligated individually.

The deep inguinal nodes lie in the areolar tissue about the femoral vessels beneath the fascia lata and superficial to the muscular fascia. At the inferior extent of the femoral triangle, the dissection must be carried down to the

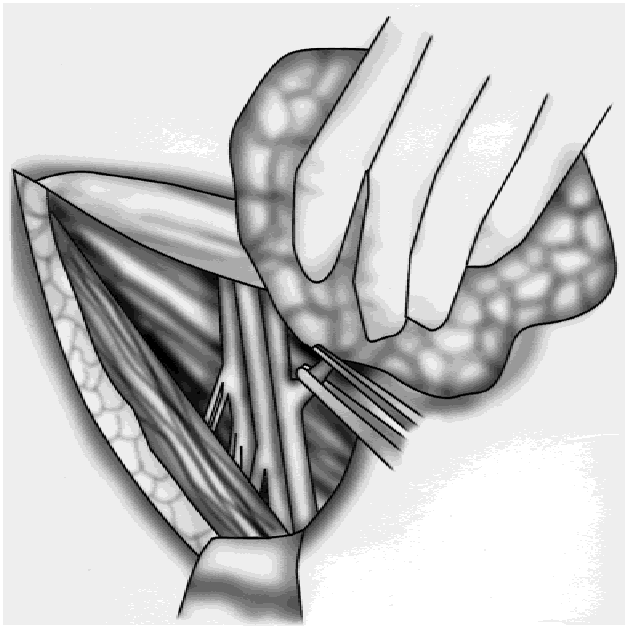

Fig. 8. Near the medial margin of the sartorius muscle, the lower branches of the femoral nerve will be encountered. These are traced upward to the appearance of the main trunk of the nerve. The fascial attachments to the inguinal ligament are detached laterally. The femoral sheath is entered, and the femoral artery and vein are dissected clean. The saphenous vein will be encountered a second time as it traverses the fossa ovalis to enter the femoral vein. It is divided and tied with a 2-0 silk ligature reinforced with a suture ligature. Medially, the quadrilateral block has been incised over the pectineus muscle, and the specimen remains attached only by the lymphatic cord and surrounding fat passing into the femoral space medial to the femoral vein. Reproduced with permission from Spratt et al. [5].

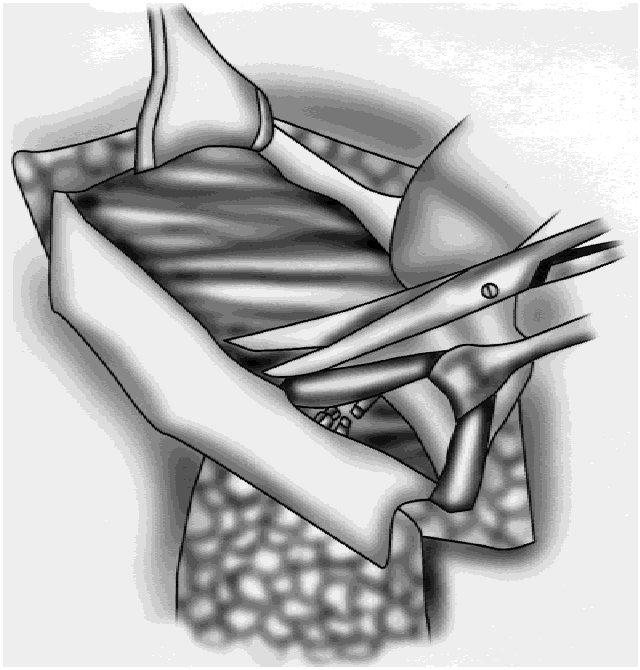

Fig. 9. The external oblique aponeurosis has been divided at the upper margin of the external inguinal ring for the length of the oblique incision. The fibers of the transversus abdominis and obliquus internus muscles are separated from the inguinal ligament. In Hesselbach's triangle, the attachments of the transversalis fascia to the inguinal ligament are thin and easily divided, except for the thickened interfoveolar ligament containing the inferior epigastric vessels. This ligament and the vessels must be divided before the retroperitoneal space can be entered. Reproduced with permission from Spratt et al. [5].

adventitial surface of the femoral artery and vein. These vessels are then cleanly dissected of all adherent areolar tissue. All branches on the anterior, medial, and lateral surfaces are transected individually and ligated near the main vessel. Included among these will be the upper end of the saphenous vein (Fig. 8). After it traverses the foramen ovalis of the fascia lata, it enters the femoral vein and must be ligated with a simple ligature and a suture ligature a second time flush with the main trunk of the femoral vein. The lymphatics of the femoral region are confluent with the iliac lymphatics through the femoral space. Here also lies the major deep inguinal lymph node, Cloquet's node.

At this point, further dissection in the groin is discontinued. When a radical vulvectomy or other perineal procedure is to be combined with a groin dissection, the medial division of the superficial and deep fascia overlying the pectineus muscle is delayed until the iliac and obturator dissections have been performed. The iliac lymph cord subsequently will be brought beneath the inguinal ligament and reflected medially with the perineal structure by dissecting deep to the fascia overlying the pectineus muscle.

APPROACH FOR ILIAC DISSECTION

The oblique incision permits easy access with good exposure for dissection of the iliac lymph nodes. First, the external oblique aponeurosis is incised in line with its fibers at the upper margin of the external inguinal ring for the entire length of the incision. The plane beneath the lower flap of external oblique aponeurosis is laid open sharply down to the inguinal ligament. In male patients, the spermatic cord is retracted superiorly. In female patients, the round ligament will have been transected at an earlier point in the operation and reflected interiorly with the superficial inguinal dissection.

At the lateral margin of Hesselbach's triangle overlying the inferior epigastric vessels is the interfoveolar ligament. This ligament is incised, and the inferior epigastric artery and vein are individually ligated and transected at the abdominal margin of the ligament (Fig. 9). These epigastric vessels will be transected a second time flush with the external iliac vessels. The tissue between the 2 points of ligation will be included in the dissection. The lateral suprafemoral lymph node lies in the areolar tissue at about the origin of the inferior epigastric and deep circumflex iliac arteries [15]. Aside from the interfoveolar ligament, the attachment of the transversalis fascia to the inguinal ligament is loose and easily divided.

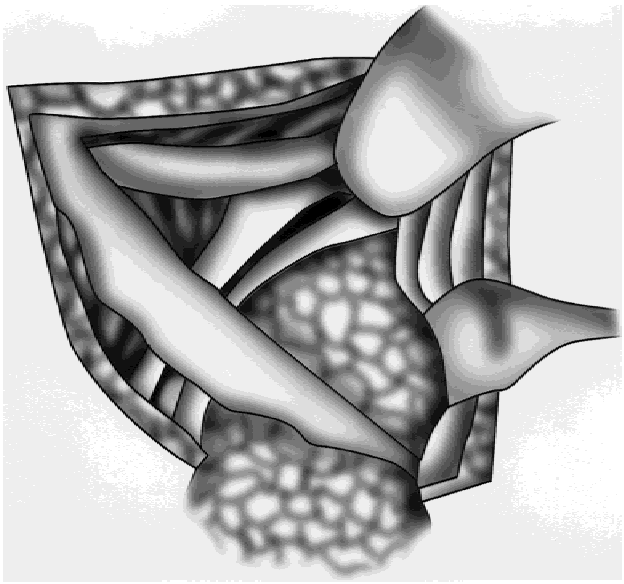

Fig. 10. The peritoneum exposed, it is stripped away from the lateral pelvis up to the bifurcation of the iliac vessels. The ureter remains adherent to the peritoneum and should be visualized at the apex of this dissection. The spermatic cord, ureter, bladder, and peritoneum are retracted medially with 1 or 2 deep-bladed retractors. Laterally, the genitofemoral nerve will be seen through the endopelvic fascia overlying the psoas muscle. The fascia is incised just medial to the nerve and reflected from the underlying muscle, the angle between the muscle and the external iliac artery, and the artery to a point just above the iliac bifurcation. Reproduced with permission from Spratt et al. [5].

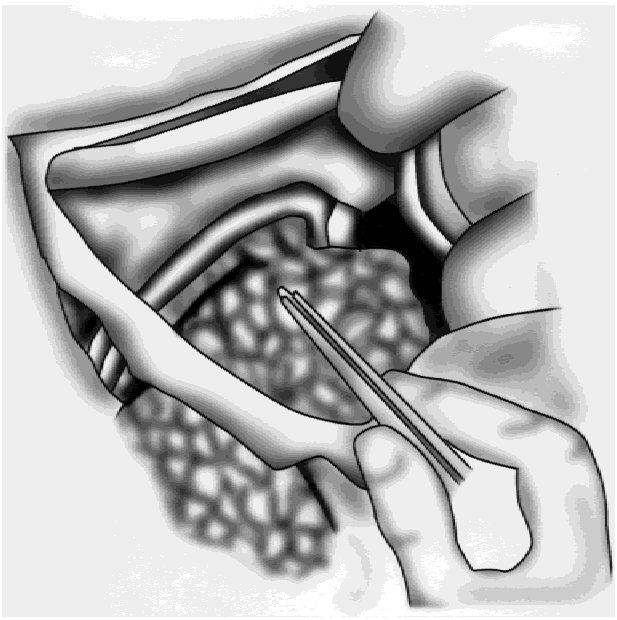

Fig. 11. The previous dissection of the endopelvic fascia now forming the sheath of the iliac vessels is continued, to expose the external iliac vein. The relation of the iliac lymphatic cord to this dissection is described in detail in the text. Reproduced with permission from Spratt et al. [5].

The dissection then is continued deeply and laterally, dividing some of the lower transversus abdominis muscle fibers and the obliquus internus muscle fibers laterally along the inguinal ligament to the anterior superior iliac spine (Fig. 10). The peritoneum is exposed throughout the depth of the wound. The peritoneum is stripped up from the lateral pelvic wall by gentle blunt dissection. The ureter will be located at the upper extent of the dissection and left adherent to the peritoneum. The ureter marks the bifurcation of the common iliac artery, and the upper point of the dissection is just proximal to this bifurcation. Exposure of the iliac region is assured by placing a gauze-covered Deaver or Harrington retractor against the peritoneum to hold it away from the lateral pelvis. Large-bladed, self-retaining retractors may also be used for the deep exposure.

ILIAC DISSECTION

The important anatomy of the 3 chains of external iliac lymph nodes was discussed earlier. From the surgical standpoint, the major lymph cord is continuous with the deep inguinal lymph cord coming upward from the thigh through the femoral space. Viewed from above, the femoral space is continuous with the inguinopectineal triangle [16]. This triangle is bounded by the inguinal ligament, the external iliac artery, and the pectineal crest. The apex of the triangle is at the pubic tubercle, and the base is on the artery. The object of the en bloc operation is to dissect the iliac lymph cord from top to bottom, free it from its fibrous attachments to the margin of the inguinopectineal triangle, pass it beneath the elevated inguinal ligament, and remove it en bloc with the deep and superficial inguinal dissections.

The 3 chains of iliac lymph nodes lie in a plane of fatty areolar tissue bounded on the lateral margin by the genitofemoral nerve lying on the anterior surface of the psoas muscle and on the other margin by the arcus tendineus at the origin of the levator ani muscle. The deep surface of the plain is the parietal layer of the endopelvic fascia. The inner surface is composed of the visceral endopelvic fascia from which the peritoneum was stripped. Between these fascial layers lies the areolar tissue containing the iliac lymphatic cords. The parietal and visceral fascias are confluent laterally on the psoas muscle. The dissection begins by incising the endopelvic fascia just medial to the genitofemoral nerve from the inguinal ligament to above the bifurcation of the common iliac artery (Fig. 11). Dissecting on the adjacent psoas muscle, the fascia is reflected medially to the lateral margin of the iliac vessels.

As Rouviere [14] noted, nodes of the lateral iliac chain tend to nestle in the interstices between the iliac artery and the psoas muscle. Consequently, the external iliac artery should be rolled medially, and the enveloping fascia of the vascular sheath should be incised deep in the interstices and then reflected up and over the artery. The space between the artery and the muscle must be dis-

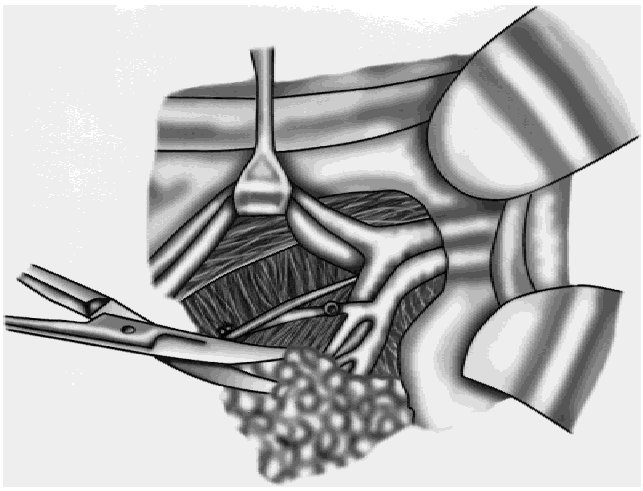

Fig. 12. The external iliac vein is elevated with a vein retractor to expose the obturator fossa containing the medial chain of the obturator lymph nodes. The obturator fascia is dissected away from the obturator internus muscle, and the obturator nerve is isolated from the fascia. Superiorly, the lymphatic cord has been transected overlying the common iliac artery, and dorsally the obturator fascia will be detached from the arcus tendineus to complete the iliac dissection. Reproduced with permission from Spratt et al. [5].

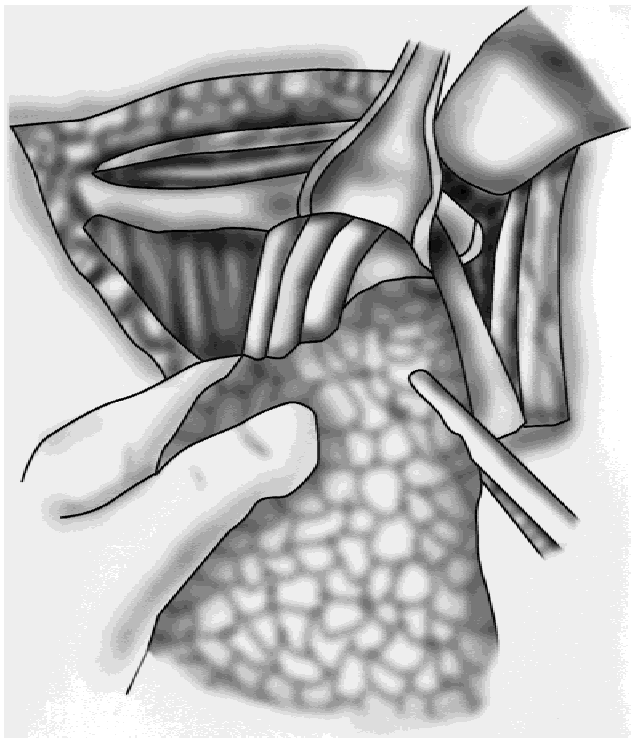

Fig. 13. The inguinal ligament is then elevated. The iliac lymph cord is passed beneath the inguinal ligament and detached from the inguinopectineal triangle to complete the en bloc ilioinguinal dissection. Reproduced with permission from Spratt et al. [5].

sected clean. The dissection then continues by reflecting the vascular sheath away from the external artery and vein down to the deep margin of the vein. The origin of the inferior epigastric artery and vein will be exposed, and they are transected a second time adjacent to the iliac vessels. At this point, the upper end of the lymph cord can be transected overlying the distal common iliac artery (Figs. 12, 13). The bundle of areolar tissue and fascia present at the apex of the dissection should be transected and ligated to occlude the lymphatics. The entire lymphatic bloc is then brought beneath the inguinal ligament after completion of dissection, described below.

The medial chain of external iliac nodes is a very important one. The most peripheral or inferior node in this chain lies on the iliopectineal line and is a direct extension of the chain of deep inguinal or Cloquet nodes [15]. Complete removal of the medial chain of iliac lymph nodes requires that a clean and complete dissection of the obturator fossa be performed. To do this, the external iliac vein must be retracted ventrally and laterally with a vein retractor. The endopelvic fascia forming the vascular sheath is dissected completely from the undersurface of the iliac vein from the inguinopectineal triangle to the bifurcation of the vein. This dissection must be continued through the endopelvic fascia enveloping the iliac vessels as the deep part of the vascular sheath.

When the deep portion of the vascular sheath has been incised, the bare muscle fibers of the obturator internus muscle will be exposed. A plane then exists between the parietal layer of the endopelvic fascia and the obturator internus muscle, which can be opened completely by gently spreading the scissor points. The obturator veins are encountered during this step. These veins go from various points on the iliac veins to the obturator foramen. They are inconsistent in their anatomical location and must be watched out for and ligated or clipped as they are encountered. Careless transection of these vessels or avulsion of them from either the obturator foramen or the iliac vein can result in very troublesome hemorrhage. The management of operative hemorrhage from pelvic veins is discussed in the following paragraphs.

The obturator nerve is located near the midpoint in the obturator fossa. Here, it passes from beneath the medial border of the psoas muscle near the brim of the pelvis, going toward the upper part of the obturator foramen. It passes beneath the iliac vessels near the bifurcation of the common iliac vein. The shiny fibers of this nerve, which is about 2 to 3 mm in diameter, can be seen through the thin covering layer of fascia. It is dissected from the fascia throughout its length in the obturator fossa and reflected laterally. A vein retractor is helpful in retracting the nerve for this dissection. Occasionally, enlarged cancerous lymph nodes in the medial chain will involve the obturator nerve. It can be sacrificed unilaterally with negligible morbidity. If the obturator nerves are sacrificed bilaterally, the patient will have a great deal of difficulty in walking because of resultant adductor palsy in both lower extremities.

Deep in the obturator fossa and dorsal to the medial chain of the iliac lymph cord, the areolar tissue and fascia become attenuated and can be transected at the arcus tendineus formed on the inner surface of the obturator internus muscle by the origin of the levator ani muscle. The arcus tendineus extends from the ischial spine to the pubis and marks the junction between the intrapelvic and extrapelvic obturator fascias [16]. The iliac lymph cord is completely mobilized and can be freed from the margin of the inguinopectineal triangle. The inguinal ligament is elevated by a retractor, and the lymph cord is delivered into the femoral triangle for completion of the en bloc dissection. If the iliac lymph cord will not pass easily beneath the inguinal ligament, the ligament may be transected near the pubic tubercle, laying open the roof of the inguinopectineal triangle. Rather than dividing the inguinal ligament, the bloc can sometimes be transected between ligatures at it narrowest point and removed in 2 parts.

Dissection of the iliac lymph cord can be exceedingly simple in a thin patient with a clean pelvis. It can be very tedious in patients who are excessively obese, have received irradiation to the lateral pelvis, have had pelvic inflammation, or have enlarged lymph nodes. In these latter instances, the technical pitfall causing the most trouble to the occasional surgeon is entry into one of the deep pelvic veins or avulsion of small, unsuspected branches.

Blood from injured major deep pelvic veins can obscure an operating field in an instant. Blind clamping in a bloody field can do irreparable damage. The first principle is to avoid these situations by maintaining careful stepwise exposure with anatomically oriented avascular fascial plane dissection. Generally, the thin-walled deep pelvic veins are easily torn by clamps. Preferably, the veins to be ligated or clipped should be identified and isolated by careful dissection. Then ligatures can be passed around the veins, and they can be ligated proximal and distal to the point of intended transection. No clamps need to be placed on the veins. Alternatively, they can be clipped. Small rents in the iliac vein produced by direct trauma or the avulsion of small branches are managed by immediate occlusive pressure from a sponge stick. Sponge sticks are then applied firmly above and below the rent. The covering sponge is removed from the rent, and the rent is closed with continuous 5-0 swaged-on arterial sutures while an assistant keeps the field dry.

If veins are avulsed flush with apertures in the lateral pelvic parietes, the end retracts into the aperture and cannot be clamped. Hemorrhage can be controlled immediately by sponge pressure over the aperture. The aperture can then be sewn closed over the end of the vein with 0-chromic catgut sutures swaged onto a general closure needle (CT-1; Ethicon, Somerville, NJ). The use of sturdy swaged-on sutures is important because larger-caliber needles may compound the avulsion and smaller needles or needles not swaged onto the suture may be lost in the field. A 10-inch vascular needle holder is required.

Managing arterial hemorrhage is generally simpler than managing venous hemorrhage. The arterial wall is tough enough to tolerate both suture closure of small rents and cross-clamping of transected ends.

CLOSURE OF THE WOUND

Careful anatomical reconstruction of the lower abdominal wall is pertinent to primary wound healing and the prevention of later herniating. If the inguinal ligament was transected, it should be repaired. Medially, the inguinopectineal triangle is covered with fascia as for a direct hernia repair. If this is not done, a direct hernia through Hesselbach's triangle can be a late complication of the operation. The free margin of the conjoined tendon, including transversalis fascia, is approximated to the pectineal line (pectineal ligament or Cooper's ligament), from the pubic tubercle to the medial margin of the femoral vein, by a row of interrupted heavy nonabsorbable sutures. To place these sutures properly through the thickened periosteum of the pectineal line, a Mayo needle (ECT-3, Ethicon) is employed. Laterally, the transected fibers of the transversus abdominis and the obliquus internus muscles are sutured to the deep portion of the inguinal ligament with interrupted or running 2-0 nonabsorbable sutures. Closure of the external oblique aponeurosis is by simple approximation using interrupted or running 2-0 sutures, either nonabsorbable or with delayed absorption.

Next, the sartorius muscle is transected adjacent to the anterior superior iliac spine, and the muscle is reattached medially to cover the femoral artery and vein. The end of the muscle is sutured to the inferior margin of the inguinal ligament directly over the upper end of the femoral vessels. Lateral and medial to the vessels, the free margin is sutured to deeper muscles, completing the secure coverage of the femoral vessels. If enough tissue has been sacrificed to make coverage of the femoral vessels tenuous, plastic surgery may be required to cover with a myocutaneous flap.

After completion of the deep closure, the skin flaps are inspected carefully. If a portion of the flap margin has become dusky or no longer blanches with pressure, it is best excised. Whenever skin has been sacrificed by the removal of a portion of the groin dissection flap or by the performance of a vulvectomy, primary closure is rarely possible except under tension. Aside from producing distraction to the wound margins, tension frequently tents the flaps up across underlying dead space, permitting fluid collection and delayed healing, with the risk of infection. All skin margins should be permitted to fall smoothly onto the contour of the wound in complete

approximation to all of the underlying structures. Where skin edges fall together, they may be approximated with interrupted subcutaneous absorbable sutures [3-0 polyglactin 910 (Vicryl)] and continuous absorbable subcuticular sutures (4-0). Minimizing the use of skin sutures and staples is preferred. Where skin edges do not approximate, the margins of the skin flaps should be sutured to the underlying muscle with interrupted absorbable sutures between the layer of the flap and the muscle.

The subcutaneous muscle not covered primarily by skin flap is covered by a split-thickness skin graft. The skin graft is fastened to the margin of the flaps by sutures, and the suture ends are left long and uncut. All air bubbles and fluid are expressed from beneath the surface of the skin graft so that nothing is interposed between the deep surface of the graft and the muscle. The graft is then covered with Telfa (The Kendall Company Ltd, Mansfield, MA) and fluffed gauze, and the long ends of the sutures are tied firmly over the fluffed gauze, crisscrossed in all directions to ensure even pressure on the underlying skin graft. Alternatively, a meshed graft can be stapled in place.

This same method of closure by skin grafting applies equally well to closure after vulvectomy. Johanson and Lewin [33] reported satisfactory results with the routine utilization of primary skin grafting after radical vulvectomy and groin dissection. Primary split-thickness skin grafting was used routinely at EFSCH for coverage after vulvectomy. The prompt, primary wound healing obtained by applying skin grafts to inguinal and vulvar defects is very gratifying. The graft may be compressed occasionally into the vulvar defect more effectively if an indwelling catheter does not pass through the urethra. After the skin graft is sutured to the margin of the urethra, the bladder may be inflated through a urethral catheter. Then, a large trocar is inserted suprapubically through the space of Retzius into the distended bladder. A Foley or mushroom catheter is then inserted through the trocar, and the trocar is removed, leaving the indwelling catheter in place. The urethral catheter is then removed, and the urine is diverted away from the surgical area by suprapubic cystotomy.

With either complete primary closure or partial closure with skin grafting, it is pertinent that the wound be made as airtight as possible. This is necessary because suction catheters are used routinely for drainage, and the application of pressure by heavy dressings on the thin flaps is to be avoided. Two catheters are used, attached to continuous suction. The proximal ends of the catheters are brought out through stab with a trocar on the lateral thigh and abdomen. One catheter passes transversely across the wound under the upper flap and one passes under the lower flap. The proximal ends are attached to continuous suction. These catheters are inserted before the skin flaps are closed. Suction is continued until the 24 hr output from each drain is less than 25 ml. Drainage catheters should never be brought to the skin surface medially.

POSTOPERATIVE CARE

The proper postoperative management of the patient after a groin dissection is as pertinent to the reduction of morbidity as is a well-executed surgical procedure. The general principles of postoperative care related to care of the cardiopulmonary system and urinary tract, fluid therapy and alimentation, care of the bowels, and general nursing care are not discussed in detail. Rather, those procedures peculiar to the care of patients having groin dissections and related organ resections will be enumerated.

Alimentation and the Bowels

If the peritoneal cavity has not been opened, alimentation as tolerated can usually begin as soon as the risk of postanesthetic gastric dilatation has passed. In the presence of any regurgitation or tympany to percussion over the gastric region, a nasogastric tube should be passed and left to drain or on low suction for at least 24 hr.

Preoperative mechanical cleansing of the bowels simplifies postoperative management. A bowel movement is not necessary for several days, after the risk of fecal contamination of a fresh wound is diminished. If a bowel movement has not occurred by the fifth postoperative day, the patient should receive a bisacodyl (Dulcolax; Ciba, Woodbridge, NJ) suppository, followed in 5 hr with a saline enema of 500 to 1,000 ml, well supervised by the nurse so that the passage of fecal matter does not contaminate the wound. Additional enemas may be required rarely every several days while the patient is restricted to bed.

Urinary Tract

Catheterization with all aseptic and antiseptic precautions should be performed in the operating room after the patient is anesthetized, to keep the bladder empty during the iliac dissection and to monitor intraoperative urinary output. The amount of pelvic manipulation involved in a groin dissection, the age of the patient, the delay in ambulation attending this operation, and the need to keep the wounds dry of urine require that the catheter be left in place as long as the patient is confined to bed postoperatively. Sufficient intake of fluid to maintain an adequate urinary output of 30 to 50 ml/hr of medium-range specific gravity is essential. Antibiotics probably will not prevent an invasive urinary tract infection secondary to catheterization, but specific drugs should be used when the presence of invasive urinary tract infections is confirmed.

Drainage, Lymphatic Regeneration, and the Prevention of Lymphedema

Numerous major afferent lymphatics are transected during a groin dissection, and large segments of lymphat-

ics are resected. The open flow of lymph into a groin dissection is simple to demonstrate by lymphography. This flow can be reduced by the operative precaution of cross-clamping and ligating the areolar tissue and fascia at the periphery of the quadrilateral block and at the apex of the iliac lymph cord. In the postoperative period, the physiological principles governing the volume and rate of flow of lymph from an extremity should be kept in mind: essentially, no lymph comes from a motionless extremity, but the flow increases proportionately with the degree of either active or passive motion in the extremity. In the postoperative period, lymph flow from the lower extremity should be kept at a minimum until the inguinal incisions are healed and ample time has elapsed to permit the regeneration of lymphatics or the opening of anastomotic lymphatics. Lymph accumulation in tissues is minimized by the use of graded elastic stockings. I have never seen thrombophlebitis in these cases, but with high-risk patients, there is no contraindication to anticoagulation.

The rate and density of lymphatic regeneration are influenced by the healing of the wound [19]. Butcher and Hoover [20] demonstrated, by injection of sky-blue dye of the superficial dermal lymphatics, that these lymphatics convey dye across linear incisions in humans at about the fifteenth postoperative day, in wounds healing per primam. Reichert [21] showed, in dogs, that superficial lymphatics can become confluent across a cleanly healing, well-approximated wound as early as the fourth postoperative day but that deeper lymphatics regenerate more slowly than do superficial ones. Reichert [21] also observed that lymphatics are sufficiently functional to keep an extremity free of edema after the eighth postoperative day with healing per primam. When segmental resection of lymphatics is performed, as in a groin dissection, the establishment of anastomotic channels is an important mechanism for reestablishing lymph flow [24]. In wounds that healed per secundam, the superficial dermal lymphatics remained sparse in number many years after healing. Regeneration is delayed by infection, excessive scar tissue formation, and prior administration of radiotherapy.

To prevent persistent lymphedema, the extremity must never be permitted to become dependent or active until the inguinal incision has healed with no residual fluid beneath the flaps. If an extremity below a groin dissection is once permitted to become and remain edematous, the cycle of fibrosis and further lymphatic obstruction secondary to the stagnation of protein-rich lymph sets in. The extremity may develop subcutaneous fibrosis, and the lymphedema may become intractable [23]. The combination of regional lymph node dissection and radiotherapy deters lymphatic regeneration and sclerosis of additional lymphatics, greatly increasing the risk of lymphedema [34].

The evolution of fibrokeratotic lymphedema is insidious. Prevention begins with preoperative and postoperative patient education on extremity care, including avoidance of trauma and infection and prompt removal of soft lymphedema by diuretics, massage, elevation, and compression before fibrosis sets in. All operations to correct advanced fibrokeratotic lymphedema are morbid, and none produces completely satisfactory results [5,23]. This fact alone mandates a proactive prevention program. In the case of either unilateral groin dissection or bilateral groin dissection without any associated perineal or genital surgery, management is relatively simple. The lower extremities are kept in the elastic stockings, which are placed preoperatively or immediately postoperatively. The drain catheters are kept running on suction until fluid output is less than 25 ml/day from each catheter, and then they are removed. Their removal before the fifth postoperative day is rarely advisable. Dependent positioning of the lower extremities should be avoided. By about the tenth postoperative day, it should be obvious whether the wound is healing per primam without fluid accumulation beneath the flaps. When this is evident, the patient can be permitted to ambulate; but effective compression of the feet, calf, and lower thigh by the elastic stocking must be maintained for at least 6 additional weeks. The patient should be instructed not to let the feet hang dependently when sitting to rest. A footstool should be available when sitting, and the feet should be elevated at night. The same precautions are required if the inguinal lymph nodes are irradiated [32].

Complication of the postoperative course by fluid accumulation beneath the flaps, the development of a lymph fistula, or delay in wound healing necessitates prompt immobilization of the lower extremity to arrest the flow of lymph. Many arguments for limiting the scope of regional lymph node dissections are based on the fear of lymphedema. A proactive prevention program, as just described, is very effective at preventing lymphedema, even when complete ilioinguinal lymph node dissections are performed.

Perineal and Vulvar Hygiene

Cancer of the vulva frequently occurs in obese elderly women. The redundant skin on the inner thighs falls together, holds moisture for the incubation of bacteria, distracts fresh wound closures, tugs upon indwelling urethral catheters, and generally makes the nursing care of vulvectomy patients difficult. An incontinent bowel movement in the early postoperative period and a shortage of adequate nursing personnel to care for these patients may well compound the problems. The wound and nursing care of these patients can be made much simpler by taking the time to apply an orthopedic device intended to keep both hips in full abduction for 5 days. The patient can be tilted from side to side to permit nursing care of

the back and buttocks without abrading the vulvar wound. By providing an overhead trapeze, the patient can pull up and move about in bed.

Care of the Wound and Skin Grafts

Fresh incisions are not dressed, permitting frequent inspection and cleansing of the flaps. The gauze stents on the skin grafts are left on for about 5 days and then removed. Any blebs that appear beneath the grafts are incised and evacuated with proper aseptic precautions. The surface of the graft is kept clean of serous encrustations by careful cleansing with cotton balls impregnated with isotonic saline solution. Meshed split-thickness skin grafts stapled to wound margins are preferred by some surgeons. With this technique, no dressing is applied and grafts can be easily inspected and cleaned.

In spite of all precautions, ischemic infarction of flaps may occur during the postoperative period. The resulting eschar produces a closed space beneath it where it can develop. If left unattended, this infection cannot drain to the surface and may dissect beneath the upper and lower flaps, producing a massive wound infection including necrotic fascitis. Patients developing areas of obvious flap infarction should be returned to the operating room as soon as the completeness of the infarction is certain. With complete operating room asepsis as for the primary operation, a split-thickness skin graft is taken from a remote donor site and the donor site is dressed. Then, the area of flap infarction is excised completely, and meshed grafts are placed over the open wound. If excision of the infarcted area is delayed until infection beneath the eschar has intervened, skin grafting may have to be delayed. Bacterial cultures should be taken of all infected wounds. Contaminated open wounds clean up most rapidly if managed as infected burns by application of intermittent soaks and silver sulfadiazine. As soon as the granulating surface is present, skin grafts may be applied.

EXPOSURE OF THE FEMORAL ARTERY

In earlier years, there were several instances of exposure of the femoral artery in an infected wound followed by erosion of the artery and massive hemorrhage. I have never seen this complication since the sartorius muscular pedicle to cover the femoral vessels became a routine part of wound closure. It is still possible, however, if the sartorius muscular pedicle retracts. Exposure of a major artery in an open wound always creates a dangerous and urgent situation because of the risk of rupture. Immediate coverage by approximating the tissues at hand or by prompt split-thickness skin grafting is sometimes possible. The prompt assistance of a plastic surgeon may be necessary to cover the exposed artery by a well-vascularized muscle pedicle. If rupture of the artery is imminent, a vascular surgeon should be consulted. Immediate control of hemorrhage is obtained by applying pressure.

In summary, groin dissection performed for complete ablation of the node-bearing areolar tissue in the inguinal and iliac regions and with negligible morbidity is a procedure that requires careful attention to the pathophysiology of cancer in lymphatics, to preoperative and postoperative care, and to surgical technique, including coordinated utilization and general, plastic, vascular, and orthopedic surgical principles.

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